3-1985

Production Systems and Costs for Producing Flowering Dogwood (*Cornus florida*) Cultivars from Budded Seedlings and from Rooted Cuttings in Tennessee, 1984

Thomas Edward Glasgow
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Thomas Edward Glasgow entitled "Production Systems and Costs for Producing Flowering Dogwood (*Cornus florida*) Cultivars from Budded Seedlings and from Rooted Cuttings in Tennessee, 1984." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Merton B. Badenhop, Major Professor

We have read this thesis and recommend its acceptance:

William M. Park, Willard T. Witte

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a thesis written by Thomas Edward Glasgow entitled "Production Systems and Costs for Producing Flowering Dogwood (Cornus florida) Cultivars from Budded Seedlings and from Rooted Cuttings in Tennessee, 1984." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Merton B. Badenhop

Merton B. Badenhop, Major Professor

We have read this thesis and
recommend its acceptance:

William M. Park

Willard T. Witte

Accepted for the Council:

Lawrence

Vice Provost
and Dean of the Graduate School

PRODUCTION SYSTEMS AND COSTS FOR PRODUCING FLOWERING DOGWOOD (*CORNUS FLORIDA*) CULTIVARS FROM BUDDED SEEDLINGS AND FROM ROOTED CUTTINGS IN TENNESSEE, 1984

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Thomas Edward Glasgow

March 1985

ACKNOWLEDGMENTS

The author expresses his appreciation to Dr. Merton B. Badenhop, Professor, Department of Agricultural Economics and Rural Sociology, for his role as Major Professor and Committee Chairman.

The author thanks Dr. William M. Park, Associate Professor, Department of Agricultural Economics and Rural Sociology, and Dr. Willard T. Witte, Associate Professor, Department of Ornamental Horticulture and Landscape Design, for serving as members of his committee.

Appreciation is also expressed to the faculty, staff and graduate students in the Department of Agricultural Economics and Rural Sociology for support and friendship throughout the author's graduate program.

Finally, the author expresses gratitude to the nurserymen who provided the information used and whose interest and cooperation made this study possible.

ABSTRACT

The objective of this study was to develop cost models for the production of flowering dogwood (Cornus florida) cultivars from budded seedlings and from rooted cuttings in Tennessee. Production data was gathered from Middle Tennessee nurserymen. Model production systems were synthesized, capital requirements identified and costs of production estimated.

Total cost of a four to six-foot flowering dogwood cultivar produced from a budded seedling was $5.47. Total cost of a four to six-foot flowering dogwood cultivar produced from a rooted cutting was $7.35. Major factors contributing to the higher cost of dogwoods grown from rooted cuttings were the costs of overwintering and propagation materials and the lower survival rate of the rooted cuttings in the field. Fixed and variable costs were considered in computation of total cost. Labor, a variable cost, was the largest cost item for both production systems followed by general overhead, a fixed cost.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

CHAPTER I

INTRODUCTION

The nursery industry is an important and growing part of Tennessee agriculture. Sales of woody ornamentals increased from $20 million in 1972 to $100 million in 1981 (9). Among row crops in Tennessee, only soybeans, corn and tobacco have greater annual production value (28). The number of certified nurserymen in Tennessee grew from 597 in 1974 to 767 in 1984. During this time, acreage in nursery stock increased from 14,714 to 25,168 (29, 9). Tennessee ranks ninth in the nation in total woody ornamental sales (12).

The flowering dogwood (Cornus florida) is one of Tennessee's most important nursery crops. A 1980 study by Badenhop indicates that the flowering dogwood and its cultivated varieties, or cultivars, comprise about 16 percent of woody ornamental production in Tennessee (2). The flowering dogwood is native to the eastern United States and is abundant in Tennessee. The bracts are the showy part of the flower and may be white, pink or red. Almost all dogwoods growing wild have white bracts. Catesby is credited with the first discovery of a pink flowering dogwood, in Virginia in 1731 (31). Since that time many other varieties have been discovered in the wild and in nursery fields. Varieties are chosen and propagated for unique color or size of flower or for attractive foliage characteristics. Table 1 presents dogwood cultivars most commonly produced in Middle Tennessee

Table 1. Cultivars of the flowering dogwood (Cornus florida) produced in Middle Tennessee[1]

Cultivar name	Characteristics
Barton	Large white bracts; early blooming
Cherokee Chief	Deep red bracts
Cherokee Princess	Large white bracts
Cloud 9	Large white bracts; prolific bloomer
First Lady	Variegated white and green foliage
Rainbow	Large white bracts; yellow and green foliage
Rubra	Naturally occurring; red or pink bracts
Springtime	Large white bracts; flowers up to five inches across
Sweetwater	Deep red bracts and reddish foliage
Variegated	White bracts; yellow and green foliage

[1]Table adapted from University of Tennessee Agricultural Extension Service Fact Sheet No. 78-5, compiled by Willard T. Witte, and from wholesale nursery catalogs.

nurseries. The native white flowering dogwood is produced commercially from seed. Its cultivars are produced either by field budding of Cornus florida seedlings or by rooting of softwood cuttings. Although field budding is the primary method used to produce cultivars, production by rooted cuttings is becoming a viable alternative method for many Tennessee growers.

Nurserymen have several reasons for attempting to produce dogwood cultivars from rooted cuttings, even though budding has been a highly successful method for many years. Dogwoods grown from rooted cuttings have straighter trunks than the budded seedlings, which tend to be slightly crooked at the seedling and bud union. Budded seedlings may be more susceptible to infestation by dogwood borers because of the trunk wound made during budding. Budded cultivars of dogwoods and other trees may produce unsightly sprouts from the understock if the top is less vigorous than the understock. This problem will not occur with dogwoods that have been produced from rooted cuttings and are growing on their own roots. Rooted cuttings can be produced using unskilled labor. Budding of dogwoods, however, requires much skill and experience, and competent budders may not be readily available when needed. The use of two different methods to produce dogwood cultivars provides the nurseryman with some insurance against total crop failure. Finally, some growers feel that rooted cuttings could provide a simpler and easier method of producing dogwood cultivars.

Significant difficulties exist in production from rooted cuttings and many nurserymen have had only limited success with this method. Growers report poor survival rates in the field, with particular difficulties in field establishment and in survival during the winter. Most Middle Tennessee nurseries do not have extensive field irrigation systems, but many growers feel that field irrigation is a necessity in the production of dogwoods from rooted cuttings. A greenhouse with misting and heating equipment is required. Young cuttings must be provided with heat while overwintering in the greenhouse. In the event of a power failure during winter most of the cuttings could be lost. Field budding will probably continue to be the most commonly employed method of producing dogwood cultivars even as growers continue to experiment with dogwood cuttings and strive for better production results.

Most nurserymen are concerned primarily with developing efficient and improved cultural practices. Generally they have limited information on costs of production. A more complete and detailed knowledge of costs becomes important to the nurseryman as input costs rise and as the industry grows and becomes more competitive. Research on costs of producing and marketing nursery products has not been extensive, particularly for specific plant species. Detailed cost information can assist growers in making product mix, pricing and marketing decisions. Prospective nurserymen and financial institutions can use cost of production information in assessing the feasibility of proposed enterprises. Limitations of cost studies, however,

should be recognized. Costs of production vary widely in the nursery industry due to differences in management, size of nursery, production facilities, cultural practices, labor and material costs, and natural resources. Nurserymen should use cost studies primarily as guides in analyzing and estimating production costs of their particular firms.

Detailed information on the costs of producing the flowering dogwood and its cultivars in Tennessee is limited and is not available for production from rooted cuttings. This study was undertaken to elaborate on cost information already developed (6) and to develop new cost information on production of dogwood cultivars from rooted cuttings. The primary objective of the study is to develop cost models for the production of flowering dogwood cultivars in Tennessee. Specific objectives are:

1. To synthesize model production systems for producing flowering dogwood cultivars from budded seedlings and from rooted cuttings.
2. To estimate costs of producing flowering dogwood cultivars.
3. To estimate the effect on costs of different assumptions about input costs and technical production coefficients.
4. To compare the costs of producing flowering dogwood cultivars by field budding and by rooting of softwood cuttings.

CHAPTER II

REVIEW OF LITERATURE

A review of the literature indicates that there is limited information available on costs of producing and marketing any particular woody ornamental nursery crop. Badenhop and Einert (6), however, completed a cost analysis study in 1979 on the production and marketing of flowering dogwoods in Tennessee. This study outlined the steps involved in producing dogwoods and estimated the costs of performing the operations involved in each of the steps.

In 1936, Surtees (26) introduced the concept of standard methods of nursery cost finding. By using standard methods, inaccurate guesswork was eliminated and the complex task of determining costs was made relatively simple. Surtees stressed that time is the basis of all costs, and the labor charts developed in his book were based on the length of time involved in performing a particular task. The information presented included allowances for delays, breakdowns and other nonproductive efforts.

Padgett and Frazier (19) discussed pricing policies and the competitive structure of the woody ornamental industry in Georgia in 1962. The authors stressed the importance of pricing plants according to production and marketing costs incurred and allowing prices to change with changes in input costs or economic conditions. Risk was also identified as an important factor to consider. Cost analyses were made of one and three-gallon container nurseries in Georgia. It

was estimated that the total cost for producing and marketing a one-gallon container plant was $0.45 compared to $1.35 for a three-gallon plant. In a later article (20) Padgett determined the cost of producing and marketing a three-year field-grown plant to be $0.85. The figures used in reaching this cost were average cost estimates taken from several Georgia nurseries. It was assumed that 75 percent of 5,500 plants lined out on an acre would develop into marketable products and would be sold. Costs were broken down into 11 categories in order to give an individual nurseryman a framework for determining his own costs. Individual plant species were not considered in the 1962 and 1966 study.

Aylesworth and Gartner (1) described the seven basic cost categories of microeconomic theory (total cost, total variable cost, total fixed cost, marginal cost, average total cost, average variable cost, and average fixed cost) and their applicability to profitable nursery production. No method for determining these costs was given. It was concluded that the most important costs for a nursery manager to consider are average variable cost and marginal cost. In a later bulletin (24) Scott and Aylesworth, using these cost principles, discussed determination of the most profitable time to market a nursery crop, based on input costs, the length of time after establishment and the rate of interest. The conclusion was that the crop should be harvested when the additional or marginal net revenue obtained by holding the crop another year is less than the average net discounted return expected from the following crop if planted in the

same parcel of land. In other words, if the expected returns from a new crop, when discounted to present value, are greater than the expected returns from holding the present crop another year before harvesting, then the present crop should be harvested now and the new crop planted. The nurseryman can achieve greater returns by beginning a new crop than by growing the present crop another year for larger salable plants.

Smeal et al. (25) discussed the economics of establishing a shade tree nursery in Virginia. Expenses for land, labor, machinery and supplies were considered, as well as a production loss of 20 percent of the trees due to mortality and unsalability. A cash flow model was developed showing variable and fixed costs incurred over an eight-year period. Annual variable costs reported in this study averaged $48,788 over the initial eight years. Fixed costs averaged $5,594.

Spacing of plants was found to be a critical factor in the profitability of one-gallon container operations in a 1974 New Jersey study by Fries and Kirschling (11). The study determined a production program, calculated costs and estimated the potential profitability and economic feasibility of investing in a container operation in New Jersey. Several plant varieties were included in the production outline. The costs of investment in an overwintering structure were outlined in detail, but the cost of land was not considered. Total costs, total revenue, economic profit and internal rate of return were calculated for 12-inch center, 8-inch center, and pot to pot

spacing in a 14 by 96-foot greenhouse. Costs per plant decreased with closer spacing, but quality also decreased leading to lower prices and profits. The internal rate of return and economic profit were found to be considerably greater for the 12-inch and 8-inch spacing than for the pot to pot spacing. The study indicated that profits and returns on investment varied widely given the different combinations of spacing and prices received.

Gunter (13) prepared reports examining average sales, costs, returns and production efficiency aspects of container nurseries in Florida. In the 1977 report, information was based on data collected from 11 nursery firms. Individual nurserymen could use the tables provided to compare their firm against industry averages and possibly to locate and correct problem areas. The information contained in the reports was valuable but very general as individual plant species were not considered.

Powers (22) examined the costs of producing ornamental plant materials in containers in Ohio. Data for the study were collected in 1977 from 10 Ohio wholesale nurseries. Eight separate cost factor divisions were defined (canning, fertilizing, weed control, shifting, pruning, spacing, overwintering and overhead) and a range of costs was developed for each division. The first section of the study dealt with costs incurred over a 12-month production cycle according to container size and producer classification (small, medium or large). The second section applied the results of the first to the cultural requirements for four different plant groups. With

this information comparisons can be made, for example, as to which cultural group incurs the highest overwintering costs, or which producer size has the lowest fertilizing costs for a particular cultural group. Information of this type can be helpful in product mix and pricing decisions. Four major conclusions were reached:

1. Plants in Group III (Chameacyparis, Pinus, and Thuja) were the most costly to produce, having longer production cycles than the other groups.
2. Production procedures, with the exception of overwintering programs, did not differ among cultural groups.
3. Production cycles increased with larger container sizes.
4. Total production costs per plant decreased as producer size increased.

Yager (33) calculated a total production cost per liner of $0.205 for Cartwright Nurseries in Tennessee in 1978. Twelve costs of production were identified and estimated, and then summed to arrive at total cost per liner. The method used to estimate the costs was not given. The costs identified were: sticking of cuttings, potting, weeding, fertilizer, soil for potting, maintenance and repairs, pots, bed preparation, supervision, employment taxes and insurance, heat (natural gas) and depreciation. Total production cost per liner was assumed to be the same for all species.

Badenhop et al. (3, 4, 5, 6, 7) have developed cost of production budgets for five nursery plants: flowering dogwood, pin oak, Kurume azalea, Burford holly and Pfitzer juniper. Budgets developed

in these studies provide valuable cost information to nurserymen, similar to that which is available through agricultural extension services to producers of corn, cotton, soybeans, and other row crops. Production systems, capital requirements, input costs, shipping costs and returns were developed from interviews with southern nurserymen and were described in detail. The nursery models were standardized in order to allow comparison of costs between the different climatic zones. Also, southern production advantages over Midwest and Northeast regions were evaluated. In a similar 1982 study, Perry and Badenhop (21) developed cost estimates for producing field-grown forsythia, and for producing Pfitzer juniper, Kurume azalea, Burford holly and crapemyrtle in one-gallon containers in Alabama. Important aspects of the study were the description of production systems and costs, estimates of the effects of varying input costs on cost-price relationships, estimates of the effects of loss rates on cost per plant and estimates of shipping costs for nursery stock shipped from Huntsville and Mobile, Alabama, to various markets in the South, Midwest, Mid-Atlantic and Northeast.

Cost data were obtained from 10 Ohio nurseries producing container stock in 1977 by Hahn et al. (14). The objectives were to determine current costs of production and to provide benchmark costs to serve as a guide in evaluating production costs. Eight different production cost divisions were determined. One analysis of costs was made on a 12-month basis for small (less than 100,000 square

feet in production area), medium (100,000 to 400,000 square feet) and large (more than 400,000 square feet) container nurseries, producing plants in one, two, and three-gallon containers, without regard to plant species. A second analysis was made to take into consideration the unique cultural requirements of different plant species. For this part of the study, plant material was organized into four cultural groupings of similarly handled genera. The conclusions reached were similar to those of Power's study (22). The cost divisions in which larger producers had an advantage were identified as overhead, canning and purchase of liners.

A computer program for determining containerized nursery production costs was developed by Robertson et al. (23). The program also compared individual costs to an industry average based on a survey of Ohio nurseries. The system could be reached from anywhere in the United States by use of a terminal and telephone. The user entered information such as direct and indirect expenses, production square footage, estimated shrinkage and desired rate of return on investment. Costs could be determined by the program for a specific plant species with varying container sizes, overwintering methods and production time.

Monrovia Nursery's propagation system and its costs were briefly described in a report by Lauderdale (17) in 1981. Total liner cost, without regard to plant species, was estimated to be $0.28, assuming a rooting success of 75 percent. Total cost was nearly equally divided between fixed and variable costs.

Kneen (16) developed cost models for container and field production of Juniperus chinensis 'Pfitzerana' in Ohio, U.S.D.A. Climatic Zone 6. Production cycles and costs were detailed for a small and large container operation and a small and large field operation. Specific objectives of the study were the development of cost models for production of 12 to 15-inch container and field-grown Pfitzer junipers in Ohio, the comparison of cost factors of producing field-grown versus container-grown Pfitzer junipers in Ohio, and the comparison of the results of the first objective with a revision of similar work done by Badenhop et al. (3). Cost of production for an Ohio field-grown 12 to 15-inch Pfitzer juniper was found to be $0.07 to $1.26 more per plant than for a two-gallon container-grown juniper, depending on size of operation. However, container operations were shown to be significantly more capital intensive than field operations. Capital investment was over $23,600 per acre for container operations, much higher than the requirements of $4,500 for field nurseries in the south and $5,780 for field nurseries in the northern zone. The study indicated that, despite higher transportation costs, Climatic Zone 7 nurseries have an absolute advantage in producing and delivering 12 to 15-inch Pfitzer junipers into the Ohio area. Production costs were 50 percent higher for field and 69 to 76 percent higher for container operations in the north as compared to southern operations. Capital requirements of southern firms were only 55 to 60 percent as high as the capital requirements of northern firms of similar size. Cultural requirements were also

found to be greater in the north, due to such factors as harsher winter climate and less rainfall in the summer.

Crafton, Phillips and Blessington (8) developed budgets for five container-grown nursery crops in U.S.D.A. Climatic Zone 8. Costs of production on a model 10-acre nursery were estimated for Burford holly, Pfitzer juniper, crapemyrtle, Kurume azalea and Fraseri photinia. Each of these plants represented a large group of similar plants. Data were obtained from nurserymen in the Mississippi-Alabama area to synthesize usual and alternate production systems for each crop. Capital requirements, fixed costs, variable costs, overhead, cost per hour of use of machinery and equipment and labor requirements were estimated in the budgets. Total costs per plant when the usual method was employed were: azalea, $1.27; Burford holly, $1.46; crapemyrtle, $1.24; photinia fraseri, $1.29; and Pfitzer juniper, $1.39. The alternate method, which represented delayed timing for some operations, resulted in slightly higher costs per plant for each of the five plant species. The report was published in 1982.

Developing an accurate and practical method of computing production and marketing costs incurred in propagation of woody ornamental cuttings in Middle Tennessee was the objective of Dickerson's 1982 M.S. thesis (9). A form developed by the Oregon State University Agricultural Extension Service for computing plant propagation production and marketing costs was modified to record expenditures made by Middle Tennessee propagators. Three nurseries supplied the data on which cost estimates were based, and three plant species were

considered. The cost of producing and marketing a salable rooted cutting ranged from $0.18 to $0.34 for andorra juniper, $0.20 to $0.43 for Hetz holly, and $0.10 to $0.40 for dwarf winged euonymus. Cash costs ranged from 61 to 79 percent of total production and marketing costs. Non-cash costs ranged from 21 to 39 percent of total costs. Labor expense was the major cost incurred in producing and marketing a cutting. Labor cost varied from 30 to 53 percent of total cost for the three species grown by the three propagators.

Costs of establishing and operating container nurseries in U.S.D.A. Climatic Zone 6 were determined by Taylor et al. (27) and reported in a 1983 bulletin. Two model firms with growing space of 15.61 and 7.81 acres were synthesized using the economic engineering framework approach. Cost of production budgets were developed for five representative groups: spreading evergreens, upright deciduous shrubs, spreading deciduous shrubs, slow-growing evergreens and broadleaf evergreens. Data for the study were obtained from wholesale nurseries and nursery suppliers during 1982. Variable costs per salable plant were shown to be nearly the same for both firm sizes while fixed costs per salable plant were substantially lower for the large firm. The study, which considered both explicit and implicit costs, indicated that in many cases wholesale prices for nursery plants in Climatic Zone 6 were lower than production costs. It was concluded that at current prices for nursery products, investment in a new container nursery in Zone 6 would yield marginal or negative returns. Capital requirements for a large and small container nursery were estimated to be $964,574 and $592,921, respectively.

CHAPTER III

METHODOLOGY

The objective of this study was to develop cost models for production of flowering dogwood cultivars in Tennessee. Two model production systems were synthesized, costs were estimated, and comparisons were made between the two systems.

Information on production practices and costs was gathered in interviews with nurserymen at 14 Middle Tennessee nurseries during 1983 and 1984. From this data, representative production cycles were synthesized for the production of dogwood cultivars from budded seedlings and from rooted cuttings. An effort was made to include in proper sequence all cultural practices necessary to the production of high quality dogwood cultivars. Field spacings and cultural practices in the field were standardized between the two systems in order to make cost comparisons as valid as possible. In addition to the development of production cycles, capital requirements were described for a model 50-acre field nursery. The nursery was assumed to be an ongoing operation.

Seven cost categories are described in microeconomic theory and can be applied to nursery production (1, 15). These are variable costs, average variable cost, fixed cost, average fixed cost, total cost, average total cost and marginal cost.

Variable costs vary directly with output. If no production is undertaken, no variable costs will be incurred. In this study, variable costs were estimated from data in the production cycles and were subdivided into four categories: materials, machinery and equipment, labor and interest on operating capital.

The costs of dogwood seed, chemicals, budding wrap, plastic pots and trays, burlap for harvest, and other items were included in the materials category. Machinery and equipment costs were calculated from information provided by the University of Tennessee Agricultural Extension Service (30) and from the required hours of use estimated in the production cycles. Field irrigation was not utilized by the production systems.

Labor was subdivided into two categories: hired and contract. Hired labor requirements vary greatly among nurseries according to managerial skill and quality of labor. Hired labor requirements were estimated from data supplied by nurserymen and were considered sufficient for all tasks described. Twenty percent was added to all labor hours to account for general maintenance of the nursery, repairs, weather losses, time between jobs and other time losses. The charge for hired labor was $4.50 per hour which included the basic wage, social security tax, worker's compensation and unemployment compensation. Contract labor is utilized by many nursery managers for specialized production tasks such as budding and suckering. Contract labor costs vary by output and the particular task performed. The contract labor charge for budding and wrapping was $0.08 per budded seedling. The charge for suckering was $0.01 per budded seedling.

Interest was charged to operating capital at 13 percent for six months of the current year and compounded annually for previous years to reflect the opportunity cost of the enterprise. Opportunity cost is the amount foregone by not investing resources in an alternative enterprise (10). In other words, it is the amount that could be earned by a resource if invested in the next best alternative enterprise.

Total variable cost for the production systems was calculated by adding the costs of materials, machinery and equipment, labor, and interest over the duration of production. Average variable cost is defined as variable cost per unit of output. Average variable cost was designated as cost per salable dogwood cultivar.

Fixed costs are incurred regardless of the level of output once investment in the firm has been made. In the long run there are no fixed costs since the manager can liquidate all assets and leave the industry. Fixed costs were estimated on the basis of capital requirements described for the model 50-acre nursery. Fixed costs included depreciation, interest, and insurance and taxes for land and improvements, buildings, and machinery and equipment, in addition to general overhead costs.

Depreciation over time of equipment or buildings can be caused by wear or obsolescence. Depreciation must be taken into account when calculating cost of production or the enterprise will appear more profitable than it actually is. By assessing depreciation costs

to the operation, the manager implicitly sets aside a fund for replacement of depreciated buildings and equipment. Depreciation was calculated using the straight line method, which is original cost minus salvage value divided by useful life in years.

Land was assumed to be non-depreciable and was assessed interest cost at 13 percent per annum. Decreasing value due to depreciation should be considered when assessing annual interest costs to buildings and machinery. Therefore, annual interest on buildings and machinery was charged at 13 percent of the average value of initial cost and salvage value. For example, a tractor with an initial cost of $19,380 and salvage value of $4,250 was assessed annual interest costs as follows: $19,380 + $4,250 ÷ 2 x .13 = $1,536.

Taxes on land were estimated at the rate of two percent per year of the assessed value, which was 25 percent of market value: $100,000 x .25 x .02 = $500. Insurance cost was not charged to land. Annual insurance and taxes for buildings and machinery were estimated at two percent of initial cost.

In addition to depreciation, interest, and insurance and taxes on land, buildings, and machinery, annual fixed costs were estimated for general overhead. Management and office personnel salaries were estimated as fixed costs since salaried personnel are paid regardless of the level of production, at least in the short run. Also included in general overhead were costs for utilities, advertising and personnel insurance.

Total fixed cost for each production system was calculated by adding annual fixed cost over the period of production. Average fixed cost was then calculated as fixed cost per salable dogwood cultivar. Total cost for the production systems was the summation of total fixed cost and total variable cost; average total cost was calculated as total cost per salable dogwood cultivar.

Marginal cost was not calculated in this study. Marginal cost is defined as the additional cost of producing one more unit of output. Similarly, marginal revenue is the additional revenue gained by selling one more unit of output (10). In microeconomic theory the optimal level of production is at the point where marginal cost is equal to marginal revenue. If marginal cost is less than marginal revenue, then additional revenue can be gained by increasing production. If marginal cost is greater than marginal revenue, then it is costing more to produce the additional units than can be recovered by selling them. Resources are being wasted and production should be decreased. This concept is understood intuitively by nursery managers even though detailed marginal cost and marginal revenue records are not kept. For example, the cost of growing and digging an additional dogwood cultivar should be no more and no less than the additional revenue generated by selling it. If it is less, additional income can be gained by growing more dogwoods and additional resources should be committed to production. If it is more, too many resources are being used by the crop and production should be

decreased. Thus, the goal of a nursery manager is not maximum production of a particular crop but production of that crop up to the point where marginal cost is equal to marginal revenue.

CHAPTER IV

RESULTS AND DISCUSSION

Production Systems

Two production systems, representative of common production practices in Middle Tennessee, were synthesized. In Production System 1, dogwood cultivars were produced by field budding of *Cornus florida* seedlings. In Production System 2, cultivars were produced by rooting softwood cuttings.

Table 2 contains data for Production System 1 which began with land preparation of a small propagation plot in September. The plot was plowed, disked, and harrowed. *Cornus florida* seed was purchased in October from local collectors and prepared for planting. The red, pulpy seed coat was removed to discourage birds from eating the seeds from the field and to aid in germination. In November the seeds were planted thickly, about 18 per foot in the row, and covered in the row with well-decayed sawdust. Upon germination, seedlings can emerge through sawdust much easier than through crusted soil. An application of 6-12-12 fertilizer completed the planting operation.

Seeds germinated by mid-April. When the seedlings had grown to three to four inches in height, they were thinned to three inches apart to allow space for budding. Between germination in April and budding in August, the crop was cultivated, fertilized, and treated with herbicide, fungicide, and insecticide.

Table 2. Estimated labor and equipment requirements for producing one acre of budded Cornus florida cultivars, 4,350 salable trees, balled and burlapped (B&B), Tennessee, 1984

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
Propagation:				
September-October 1984	Land preparation of propagation plot, .18 acre			
	Plow	Tractor, 60 Hp/plow (3-14")	0.25	0.30
	Disk - 4 times (X)	Tractor, 60 Hp/disk (8')	1.00	1.20
	Harrow	Tractor, 60 Hp/harrow (10')	0.16	0.20
	Purchase 9 lbs. seed from local collectors	--	--	--
	Prepare seed for planting	Hand tools	--	2.00
November	Ridge up rows, 54" spacing	Tractor, 60 Hp/disc attachment	0.50	0.52
	Lay off furrows in rows	Tractor, 60 Hp/"calf-tongue" point	0.50	0.52
	Plant seed, 18 per foot	Tractor, 60 Hp/seeder	0.70	0.72
	Apply fertilizer (6-12-12 @ 500 lbs./ac.)[b]	Tractor, 60 Hp/fertilizer sidedresser	0.20	0.22
	Cover seed with sawdust	Pickup truck, front end loader, hand tools	2.00	6.00
April 1985	Seeds germinate, April 1-15			
May-June	Thin seedlings to 3" apart for budding	Hand	--	13.00
	Cultivate, apply fertilizer (15-15-15 @ 500 lbs./ac.)	Tractor, 60 Hp/cultivator, sidedresser	0.27	0.50
	Hoe	Hand tools	--	9.00
	Apply herbicide (Surflan)	Tractor, 60 Hp/boom sprayer (10')	0.25	0.50
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 60 Hp/boom sprayer (10')	0.50	1.20
July	Cultivate, apply fertilizer (15-15-15 @ 500 lbs./ac.)	Tractor, 60 Hp/cultivator, sidedresser	0.27	0.50
	Apply fungicide and insecticide (Manzate - 1x, Dursban - 1x)	Tractor, 60 Hp/boom sprayer (10')	0.25	0.52
August	Collect budwood, 1 day in advance of budding	Hand tools	--	7.50
	Bud 6,912 seedlings	Contract labor	--	--

Table 2. (Continued)

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
December	Root prune budded seedlings	Tractor, 60 Hp/undercutter	0.27	0.50
February 1986	Cut mother plant off above bud	Contract labor	--	--
	Cull inferior plants and plants not successfully budded	Hand	--	4.00
April-June	Remove suckers after bud begins growth	Contract labor	--	--
	Cultivate, apply fertilizer (15-15-15 @ 500 lbs./ac.)	Tractor, 60 Hp/cultivator, sidedresser	0.27	0.50
	Hoe	Hand tools	--	9.00
	Apply herbicide (Surflan)	Tractor, 60 Hp/boom sprayer (10')	0.25	0.50
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 60 Hp/boom sprayer (10')	0.50	1.20
	Cultivate	Tractor, 60 Hp/cultivator	0.27	0.50
July-August	Remove suckers	Contract labor	--	--
	Cultivate, apply fertilizer (15-15-15 @ 500 lbs./ac.)	Tractor, 60 Hp/cultivator, sidedresser	0.27	0.50
	Hoe	Hand tools	--	9.00
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 60 Hp/boom sprayer (10')	0.50	1.20
	Cultivate	Tractor, 60 Hp/cultivator	0.27	0.50
Field production:				
September-October	Land preparation for field growing, 1 acre			
	Plow	Tractor, 60 Hp/plow (3-14")	1.00	1.25
	Disk - 4X	Tractor, 60 Hp/disk (8')	4.00	5.00
	Harrow	Tractor, 60 Hp/harrow (10')	0.50	0.75
November	Transplant 4,833 budded seedlings to field; 54" between rows, 24" in row	Tractor, 60 Hp/transplanter, 2-row	3.00	10.00

Table 2. (Continued)

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
April-June 1987	Cultivate, apply fertilizer (15-15-15 @ 500 lbs./ac.)	Tractor, 19 Hp/rotovator, sidedresser	2.00	2.25
	Hoe	Hand tools	--	48.00
	Apply herbicide (Surflan)	Tractor, 19 Hp/boom sprayer (10')	1.00	1.25
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 19 Hp/boom sprayer (10')	2.00	2.50
	Cultivate	Tractor, 19 Hp/rotovator	2.00	2.25
July-September	Cultivate, apply fertilizer (15-15-15 @ 500 lbs./ac.)	Tractor, 19 Hp/rotovator, sidedresser	2.00	2.25
	Hoe	Hand tools	--	48.00
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 19 Hp/boom sprayer (10')	2.00	2.50
	Prune	Hand tools	--	45.00
	Cultivate	Tractor, 19 Hp/rotovator	2.00	2.25
April-June 1988	Cultivate, apply fertilizer (15-15-15 @ 500 lbs./ac.)	Tractor, 19 Hp/rotovator, sidedresser	2.00	2.25
	Hoe	Hand tools	--	48.00
	Apply herbicide (Surflan)	Tractor, 19 Hp/boom sprayer (10')	1.00	1.25
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 19 Hp/boom sprayer (10')	2.00	2.50
	Cultivate	Tractor, 19 Hp/rotovator	2.00	2.25
July-September	Cultivate, apply fertilizer (15-15-15 @ 500 lbs./ac.)	Tractor, 19 Hp/rotovator, sidedresser	2.00	2.25
	Hoe	Hand tools	--	48.00
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 19 Hp/boom sprayer (10')	2.00	2.50
	Prune	Hand tools	--	45.00
	Cultivate	Tractor, 19 Hp/rotovator	2.00	2.25
November-December	Harvest 30 percent of crop (1,305 trees), 10 percent loss in field	Contract labor	--	--
	Contract labor moves trees from field to holding area and sorts into sizes			

Table 2. (Continued)

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
March 1989	Harvest remaining 70 percent of crop (3,045 trees) Contract labor moves trees from field to holding area and sorts into sizes			

[a]The use of trade names is for illustration only and does not constitute an endorsement of any product.

[b]Fertilizer analysis may vary according to soil type.

One day before budding, budwood was gathered from the pruning of cultivars in the field. Three separate tasks are involved in budding dogwoods (18). The first is scratching, in which the lower leaves, small side limbs, and dirt or grit are removed from the seedling. Also, any gravel or debris found in the seedling row is removed. Budding is performed next, preferably within a few days of scratching. A bud is cut from a budstick, a "T" slit about one inch long is made on the seedling, and then the bud is inserted into the slit. The wrapper, immediately behind the budder, wraps the bud securely onto the seedling with a rubber strip. The rubber strip will expand with growth of the bud and will deteriorate within one month.

Six thousand nine hundred and twelve seedlings were budded. Seventy percent of these seedlings were successfully budded, providing 4,833 budded seedlings for later transplanting to one acre in the field at adequate spacings for growth into well-shaped trees. After budding was completed, the seedlings were not disturbed the remainder of the year except for root pruning in December. In February or March of the following year the seedlings were cut off just above the scion, and inferior plants were culled by hand from the propagation plot. Suckers were removed in the spring and again in the summer. During the course of the year, fertilizer was applied twice, herbicide once, insecticide twice and fungicide four times. The crop was cultivated four times and hoed by hand twice. This pattern was followed through the remainder of the production cycle.

Land preparation of one acre for field growing began in September, the year after budding. In November, 4,833 successfully budded seedlings were transplanted onto one acre at spacings of 54 inches between rows and 24 inches in the row. The height of the trees during their final two years in the field necessitated the use of a small tractor which could travel between the rows. Cultivation was then accomplished by means of a rotovator pulled behind the tractor. During the final year in the field, the quantity of herbicide and insecticide applied was increased to correspond to the growth of the trees.

The survival rate of the 4,833 budded seedlings transplanted to the field was 90 percent.[1] Therefore, 4,350 salable trees were available for harvest. The total length of time involved in Production System 1, from land preparation of the propagation plot to final harvest, was 54.5 months.

Production System 2, presented in Table 3, began with preparation of a 24 by 96-foot greenhouse in July. A medium of pine bark, native clay soil and sand was mixed by use of a rotary tiller in a propagation ground bed in the greenhouse. The medium was then fumigated using methyl-bromide, and the bed was leveled. Two and one-fourth by five-inch plastic pots in trays were filled with the medium, which was pressed firmly into the pots, and placed on top of the leveled beds. Five thousand six hundred and eighty-six six to eight-inch tip cuttings were then gathered from Cornus florida

---

[1]The loss rate of 10 percent includes trees unsalable due to inferiority.

Table 3. Estimated labor and equipment requirements for producing one acre of *Cornus florida* cultivars from softwood cuttings, 3,383 salable trees, B&B, Tennessee, 1984

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
Propagation:				
July 1984	Fill ground beds with 60% pine bark, 20% soil, 20% sand, mix thoroughly	Rotary tiller	0.25	2.00
	Fumigate medium with methyl-bromide	Hand	--	2.00
	Fill 5,686 plastic pots with medium; set in flats on top of remaining medium	Hand	--	24.00
	Take 5,686 tip cuttings from cultivar stock block, trim, quick-dip in 2% IBA, stick into plastic pots	Pickup, ½ ton	2.00	60.00
	Cover greenhouse with 2 layers of 6 mil. polyethylene film and 1 layer shade cloth	Hand	--	7.00
July-August	Mist cuttings 5 seconds every 10 minutes, 8:00 a.m. to 5:00 p.m.; continue misting 6-8 weeks or until cuttings have rooted	Mist system	3.70	1.00
	Apply fungicide (Benlate) - 1 time (x)	Sprayer, backpack	0.10	0.25
August-April	Apply fertilizer (9-45-15) - 1x after cuttings have rooted	Hand	--	0.25

Table 3. (Continued)

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
	Apply fungicide (Benlate) every 30 days - 8x	Sprayer, backpack	1.50	2.00
	Apply insecticide (Sevin) - 2x	Sprayer, backpack	0.40	0.50
	Check, observe, water as needed after cuttings have rooted	Irrigation system	10.00	21.00
	Remove shade cloth in early December	Hand	--	1.00
	Keep greenhouse heat to 34° (1°C) from December 1 to mid-March	Heater	267.00	1.00
April-Oct. 1985	Remove polyethylene film from greenhouse	Hand	--	3.00
	Cover greenhouse with shade cloth	Hand	--	0.50
	Check, observe, water plants	Irrigation system	20.00	5.00
	Apply fertilizer (15-15-15) - 1x	Hand	--	0.25
	Apply fungicide (Benlate) every 30 days - 6x	Sprayer, backback	1.20	1.50
	Apply insecticide (Sevin) - 2x	Sprayer, backback	0.40	0.50
	Remove weeds - 1x	Hand	--	1.00

Table 3. (Continued)

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
Field Production:				
Oct.-Nov.	Land preparation for field growing, 1 acre Plow - 1x	Tractor, 60 Hp/plow (3-14")	1.00	1.25
	Disk - 4x	Tractor, 60 Hp/disk (8')	4.00	5.00
	Harrow - 1x	Tractor, 60 Hp/ harrow (10')	0.50	0.75
Nov.	Move 4,833 rooted cuttings to field; 54" between rows, 24" in row	Tractor, 60 Hp/ transplanter, 2-row pickup truck	4.00	10.00
April-June 1986	Cultivate, apply fertilizer (15-15-15 @ 500 lb./ac.)[b]	Tractor, 60 Hp/ cultivator, side-dresser	1.00	1.20
	Hoe	Hand tools	--	48.00
	Apply herbicide (Surflan)	Tractor, 60 Hp/ boom sprayer (10')	0.90	1.20

Table 3. (Continued)

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 60 Hp/ boom sprayer (10')	1.80	2.50
	Cultivate	Tractor, 60 Hp/ cultivator	1.00	1.10
July-Sept.	Cultivate, apply fertilizer (15-15-15 @ 500 lb./ac.)	Tractor, 19 Hp/ rotovator, side-dresser	2.00	2.25
	Hoe	Hand tools	--	48.00
	Apply fungicide and insecticide (Manzate - 2x Dursban - 1x)	Tractor, 19 Hp/ boom sprayer (10')	2.00	2.50
	Cultivate	Tractor, 19 Hp/ rotovator	2.00	2.25
April-June 1987	Cultivate, apply fertilizer (15-15-15 @ 500 lb./ac.)	Tractor, 19 Hp/ rotovator, side-dresser	2.00	2.25

Table 3. (Continued)

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
	Hoe	Hand tools	--	48.00
	Apply herbicide (Surflan)	Tractor, 19 Hp/ boom sprayer (10')	1.00	1.25
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 19 Hp/ boom sprayer (10')	2.00	2.50
	Cultivate	Tractor, 19 Hp/ rotovator	2.00	2.25
July-Sept.	Cultivate, apply fertilizer (15-15-15 @ 500 lb./ac.)	Tractor, 19 Hp/ rotovator, side-dresser	2.00	2.25
	Hoe	Hand tools	--	48.00
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 19 Hp/ boom sprayer (10')	2.00	2.50
	Prune	Hand tools	--	41.00
	Cultivate	Tractor, 19 Hp/ rotovator	2.00	2.25

Table 3. (Continued)

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
April-June 1988	Cultivate, apply fertilizer (15-15-15 @ 500 lb./ac.)	Tractor, 19 Hp/ rotovator, side-dresser	2.00	2.25
	Hoe	Hand tools	--	48.00
	Apply herbicide (Surflan)	Tractor, 19 Hp/ boom sprayer (10')	1.00	1.25
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 19 Hp/ boom sprayer (10')	2.00	2.50
	Cultivate	Tractor, 19 Hp/ rotovator	2.00	2.25
July-Sept.	Cultivate, apply fertilizer (15-15-15 @ 500 lb./ac.)	Tractor, 19 Hp/ rotovator, side-dresser	2.00	2.25
	Hoe	Hand tools	--	48.00
	Apply fungicide and insecticide (Manzate - 2x, Dursban - 1x)	Tractor, 19 Hp/ boom sprayer (10')	2.00	2.50

Table 3. (Continued)

Month	Operation description[a]	Equipment	Hours	
			Machine	Man
	Prune	Hand tools	--	39.00
	Cultivate	Tractor, 19 Hp/ rotovator	2.00	2.25
Nov.-Dec.	Harvest 30 percent of crop (1,015 trees), 30 percent loss in field; contract labor moves trees from field to holding area and sorts into sizes	Contract labor	--	--
March 1989	Harvest remaining 70 percent of crop (2,368 trees); contract labor moves trees from field to holding area and sorts into sizes	Contract labor	-	--

[a]The use of trade names is for illustration only and does not constitute endorsement of any product.

[b]Fertilizer analysis may vary according to soil type.

cultivars in the field. The cuttings were taken from the field to the preparation site on a pickup truck in a container filled with water. At the preparation site the cuttings were stripped, leaving the top two or four leaves, quick-dipped in a two-percent indolebutyric acid (IBA) rooting hormone and then taken to the greenhouse where they were stuck 1.5 to 2 inches deep into the plastic pots. Cuttings were not wounded, although cuttings of red cultivars may develop roots more readily if wounded. All cuttings were potted the same day they were taken from the field.

Roots developed within six to eight weeks. During that time, the cuttings were automatically misted daily from 8:00 a.m. to 5:00 p.m. at a setting of five seconds every 10 minutes, or 10 seconds every 10 minutes during exceptionally hot weather. After roots appeared, misting was discontinued and the plants were watered as needed. Fertilizer was applied once. Fungicide was applied every 30 days as a preventative, and insecticide was applied twice. Minimum heat was provided in the greenhouse from early December to mid-March to protect the young cuttings from freezing temperatures.

In April, the polyethylene film was taken down and the greenhouse was covered with shade cloth. Fungicide application continued as before, and insecticide was applied two more times during the summer. The rooted cuttings were also watered as needed, fertilized and weeded.

Ninety percent of the cuttings developed roots and survived through the winter and summer in the greenhouse, providing 4,833 rooted cuttings for transplanting to one acre in the field at spacings

of 54 inches between rows and 24 inches in the row. Land preparation for field growing began in October, the year after cuttings were taken. Cultural practices in the field were the same as for Production System 1. Seventy percent of the trees survived in the field, providing 3,383 salable dogwood cultivars for harvest.[2] The total length of time involved in Production System 2, from greenhouse preparation to final harvest, was 56 months.

Table 4 briefly outlines both production systems and indicates approximate height of trees for each year. Production System 2 began with six-inch cuttings which developed roots before seed was planted in Production System 1. However, rooted cuttings have no tap root and have smaller root systems than the budded seedlings, and will not grow as rapidly. Therefore, approximately the same length of time was required by both production systems to produce four to six-foot trees.

Variable Costs

Variable costs for Production System 1, production by budding, are given in Table 5. Total variable cost for the 54.5-month production system was $14,034 or $3.23 per salable tree. Variable costs for Production System 2, production from rooted cuttings, are given in Table 6. Total variable cost for the 56-month production system was $13,361, or $3.95 per salable tree. In Table 5, Production System 1 was divided into four 12-month periods, beginning with

---

[2]Some growers attain higher survival rates of rooted cuttings in the field, others much lower. Seventy percent was considered a reasonable level based on interviews with nurserymen.

Table 4. Approximate height of Cornus florida cultivars by year for two production systems, B&B, Tennessee, 1984

	Production System 1		Production System 2	
Year	Operation	Approximate height	Operation	Approximate height
July 1984	--	--	Take cuttings	6 inches
October 1984	Plant seed	--	--	--
August 1985	Bud seedlings	6-8 inches	--	--
November 1985	--	--	Move to field	1 foot
November 1986	Move to field	1.5-2 feet	--	2-3 feet
November 1987	--	2-3 feet	--	4-5 feet
December 1988 --				
March 1989	Harvest	4-6 feet	Harvest	4-6 feet

Table 5. Estimated variable costs of producing one acre of budded Cornus florida cultivars, 4,350 salable trees, B&B, Tennessee, 1984

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars ------	
Year 1: propagation					
Materials[a]	Dogwood seed	lb.	9.00	0.60	5.40
	Sawdust	ton	0.63	30.00	18.90
	Fertilizer (6-12-12)	ton	0.045	242.00	10.90
	Fertilizer (15-15-15)	ton	0.09	242.00	21.78
	Herbicide (Surflan)	gallon	0.09	53.58	4.82
	Fungicide (Manzate)	lb.	0.81	1.60	1.30
	Insecticide (Dursban)	gallon	0.18	37.10	6.68
	Budding wrap	each	6,912.00	0.003	20.74
Subtotal					90.52
Machinery and equipment	Tractor, 60 Hp	hr.	4.85	6.08	29.49
	Plow	hr.	0.25	1.28	0.32
	Disk	hr.	1.00	1.52	1.52
	Harrow	hr.	0.16	0.14	0.02
	Sidedresser	hr.	0.74	0.62	0.46
	Boom sprayer	hr.	1.00	0.74	0.74
	Cultivator	hr.	0.54	0.63	0.34
	Pickup truck	hr.	2.00	6.50	13.00
	Front end loader	hr.	1.00	9.42	9.42
Subtotal					55.31
Labor	Hired labor	hr.	44.40	4.50	199.80
	Related hired labor[b]	hr.	8.88	4.50	39.96
Subtotal					239.76
Contract labor	Scratching	seedling	6,912.00	0.01	69.12
	Budding	seedling	6,912.00	0.08	552.96
Subtotal					622.08

Table 5. (Continued)

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars -------	
Variable costs, year 1					1,007.67
Interest on operating capital, 6 months @ 13%					65.49
Total, year 1					1,073.16
Year 2: propagation					
Materials	Fertilizer (15-15-15)	ton	0.09	242.00	21.78
	Fungicide (Manzate)	lb.	1.08	1.60	1.73
	Insecticide (Dursban)	gallon	0.18	37.10	6.68
	Herbicide (Surflan)	gallon	0.09	53.58	4.82
Subtotal					35.01
Machinery and equipment	Tractor, 60 Hp	hr.	2.60	6.08	15.80
	Undercutter	hr.	0.27	0.15	0.04
	Cultivator	hr.	1.08	0.63	0.68
	Sidedresser	hr.	0.54	0.62	0.33
	Boom sprayer	hr.	1.25	0.74	0.92
Subtotal					17.77
Labor	Hired labor	hr.	27.40	4.50	123.30
	Related hired labor	hr.	5.48	4.50	24.66
Subtotal					147.96
Contract labor	Suckering	budded seedling, 4,838 - 2x	9,676.00	0.01	96.76
Subtotal					96.76
Variable costs, year 2					297.50
Interest: year 1 cost compounded @ 13% and cost of operating capital, year 2, 6 months @ 13%					158.85
Total, year 2					456.35

Table 5. (Continued)

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars ------	
Year 3: field production					
Materials	Fertilizer (15-15-15)	ton	0.50	242.00	121.00
	Fungicide (Manzate)	lb.	6.00	1.60	9.60
	Insecticide (Dursban)	gallon	1.00	37.10	37.10
	Herbicide (Surflan)	gallon	0.50	53.58	26.79
Subtotal					194.49
Machinery and equipment	Tractor, 60 Hp	hr.	8.50	6.08	51.68
	Tractor, 19 Hp	hr.	13.00	3.75	48.75
	Plow	hr.	1.00	1.28	1.28
	Disk	hr.	4.00	1.52	6.08
	Harrow	hr.	0.50	0.14	0.07
	Transplanter	hr.	3.00	1.22	3.66
	Rotovator	hr.	8.00	1.08	8.64
	Sidedresser	hr.	4.00	0.62	2.48
	Boom sprayer	hr.	5.00	0.74	3.70
Subtotal					126.34
Labor	Hired labor	hr.	173.25	4.50	779.62
	Related hired labor	hr.	34.65	4.50	155.92
Subtotal					935.54
Variable costs, year 3					1,256.37
Interest: years 1 and 2 cost compounded @ 13% and cost of operating capital, year 3, 6 months @ 13%					280.49
Total, year 3					1,536.86

Table 5. (Continued)

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars ------	
Year 4: field production					
Materials	Fertilizer (15-15-15)	ton	0.50	242.00	121.00
	Fungicide (Manzate)	lb.	12.00	1.60	19.20
	Insecticide (Dursban)	gallon	2.00	37.10	74.20
	Herbicide (Surflan)	gallon	0.50	53.58	26.79
Subtotal					241.19
Machinery and equipment	Tractor, 19 Hp	hr.	13.00	3.75	48.75
	Rotovator	hr.	8.00	1.08	8.64
	Sidedresser	hr.	4.00	0.62	2.48
	Boom sprayer	hr.	5.00	0.74	3.70
Subtotal					63.57
Labor	Hired labor	hr.	156.25	4.50	703.12
	Related hired labor	hr.	31.25	4.50	140.62
Subtotal					843.74
Variable costs, year 4					1,148.50
Interest: years 1, 2 and 3 cost compounded @ 13%, and cost of operating capital, year 4, 6 months @ 13%					473.27
Total, year 4					1,621.77
Harvest:					
Materials	Burlap, twine, nails, tags	tree	4,350	0.50	2,175.00
Subtotal					2,175.00

Table 5. (Continued)

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars ------	
Contract labor	Digging	tree	435--3'-4'	0.70	304.50
			2,610--4'-5'	0.90	2,349.00
			1,305--5'-6'	1.10	1,435.50
	Moving out of field[c]	tree	4,350	0.50	2,175.00
Subtotal					6,264.00
Variable costs, harvest					8,439.00
Interest: propagation years 1, 2, 3 and 4 compounded @ 13%, and cost of operating capital, harvest, 3.25 months @ 13%					906.57
Total harvest					9,345.57
Total variable costs					14,033.71

[a]The use of trade names is for illustration only and does not constitute an endorsement of any product.

[b]Related labor activities include time used for general maintenance of the propagation facility, repairs, purchasing supplies, time losses between jobs and other activities which could not be allocated to a specific crop. These hours were estimated at 20% of production labor hours.

[c]Includes machinery and equipment cost of flatbed truck.

Table 6. Estimated variable costs of producing one acre of Cornus florida cultivars from softwood cuttings, 3,383 salable trees, B&B, Tennessee, 1984

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars ------	
Year 1: propagation					
Materials[a]	Plastic pots[b]	each (2¼ x 2¼" x 5")	5,686	0.07	199.01
	Plastic trays	each (19" x 19" x 4")	105	0.65	34.12
	Plastic for greenhouse[c] 6 mil., clear	sq. ft.	8,000 (12% for crop)	0.06	28.80
	Plastic for fumigation 6 mil., clear	sq. ft.	3,200 (12% for crop)	0.06	23.04
	Shade cloth[c]	sq. ft.	3,770 (12% for crop)	0.14	12.67
	Soil mixture (pine bark, sand, soil)	cu. yd.	6.00	14.00	84.00
	Rooting hormone (2%, IBA)	pt.	1.00	12.00	12.00
	Fertilizer (9-45-15)	lb.	5.00	0.60	3.00
	Fungicide (Benlate)	lb.	0.30	12.55	3.76
	Insecticide (Sevin)	lb.	0.09	2.50	0.22
	Fumigant (Methyl-bromide)	lb.	5.00	1.40	7.00
	Fertilizer (15-15-15)	lb.	10.00	0.12	1.20
Subtotal					408.82
Machinery and equipment	Rotary tiller	hr.	0.25	0.97	0.24
	Pickup truck	hr.	2.00	6.50	13.00
	Misting system	hr.	3.70	0.25	0.92
	Irrigation system	hr.	20.00	0.75	15.00
	Sprayer, backpack	hr.	2.60	0.30	0.78
	Overwintering, minimum heat	rooted cutting	5,686	0.04	227.44
Subtotal					257.38
Labor	Hired labor	hr.	129.25	4.50	581.62
	Related hired labor[d]	hr.	25.85	4.50	116.32
Subtotal					697.94

Table 6. (Continued)

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars ------	
Variable costs, year 1					1,364.14
Interest on operating capital, 6 months @ 13%					88.67
Total, year 1					1,452.81
Year 2: propagation					
Materials	Fertilizer (15-15-15)	ton	0.25	242.00	60.50
	Fungicide (Benlate)	lb.	0.20	12.55	2.51
	Fungicide (Manzate)	lb.	3.00	1.60	4.80
	Insecticide (Sevin)	lb.	0.03	2.50	0.07
	Insecticide (Dursban)	gallon	0.50	37.10	18.55
	Herbicide (Surflan)	gallon	0.50	53.58	26.79
Subtotal					113.22
Machinery and equipment	Tractor, 60 Hp	hr.	14.20	6.08	86.34
	Plow	hr.	1.00	1.28	1.28
	Disk	hr.	4.00	1.52	6.08
	Harrow	hr.	0.50	0.14	0.07
	Transplanter	hr.	4.00	1.22	4.88
	Cultivator	hr.	2.00	0.63	1.26
	Sidedresser	hr.	1.00	0.62	0.62
	Boom sprayer	hr.	2.70	0.74	2.00
	Irrigation system	hr.	10.00	0.75	7.50
	Sprayer, backpack	hr.	1.00	0.30	0.30
	Pickup truck	hr.	1.00	6.50	6.50
Subtotal					116.83
Labor	Hired labor	hr.	75.5	4.50	339.75
	Related hired labor	hr.	15.1	4.50	67.95
Subtotal					407.70
Variable costs, year 2					637.75

Table 6. (Continued)

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars ------	
Interest, year 1 cost compounded @ 13% and cost of operating capital, year 2, 6 months @ 13%					230.31
Total, year 2					868.06
Year 3: field production					
Materials	Fertilizer (15-15-15)	ton	0.50	242.00	121.00
	Fungicide (Manzate)	lb.	6.00	1.60	9.60
	Insecticide (Dursban)	gallon	1.00	37.10	37.10
	Herbicide (Surflan)	gallon	0.50	53.58	26.79
Subtotal					194.49
Machinery and equipment	Tractor, 19 Hp	hr.	13.00	3.75	48.75
	Rotovator	Hr.	8.00	1.08	8.64
	Sidedresser	hr.	4.00	0.62	2.48
	Boom sprayer	hr.	5.00	0.74	3.70
Subtotal					63.57
Labor	Hired labor	hr.	111.25	4.50	500.62
	Related hired labor	hr.	22.25	4.50	100.12
Subtotal					600.74
Variable costs, year 3					858.80
Interest: years 1 and 2 cost compounded @ 13% and cost of operating capital, year 3, 6 months @ 13%					357.53
Total, year 3					1,216.33
Year 4: field production					
Materials	Fertilizer (15-15-15)	ton	0.50	242.00	121.00
	Fungicide (Manzate)	lb.	7.80	1.60	12.48
	Insecticide (Dursban)	gallon	1.30	37.10	48.23
	Herbicide (Surflan)	gallon	0.50	53.58	26.79
Subtotal					208.50

Table 6. (Continued)

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars ------	
Machinery and equipment	Tractor, 19 Hp	hr.	13.00	3.75	48.75
	Rotovator	hr.	8.00	1.08	8.64
	Sidedresser	hr.	4.00	0.62	2.48
	Boom sprayer	hr.	5.00	0.74	3.70
Subtotal					63.57
Labor	Hired labor	hr.	152.25	4.50	685.12
	Related hired labor	hr.	30.45	4.50	137.02
Subtotal					822.14
Variable costs, year 4					1,094.21
Interest: years 1, 2 and 3 cost compounded @ 13% and cost of operating capital year 4, 6 months @ 13%					530.95
Total year 4					1,625.16
Field production, harvest:					
Materials	Fertilizer (15-15-15)	ton	0.25	242.00	60.50
	Fungicide (Manzate)	lb.	4.80	1.60	7.68
	Insecticide (Dursban)	gallon	3.20	37.10	118.72
	Burlap, twine, nails, tags	tree	3,383	0.50	1,619.50
Subtotal					1,806.40
Machinery and equipment	Tractor, 19 Hp	hr.	6.00	3.75	22.50
	Rotovator	hr.	4.00	1.08	4.32
	Sidedresser	hr.	2.00	0.62	1.24
	Boom sprayer	hr.	2.00	0.74	1.48
Subtotal					29.54

Table 6. (Continued)

Item	Description	Unit	Quantity	Cost per unit	Total
				------ dollars ------	
Labor	Hired labor	hr.	94.00	4.50	423.00
	Related hired labor	hr.	18.80	4.50	84.60
Subtotal					507.60
Contract labor	Digging	tree	340--3'-4'	0.70	238.00
			2,029--4'-5'	0.90	1,826.10
			1,014--5'-6'	1.10	1,115.40
	Moving out of field[e]	tree	3,383	0.50	1,691.50
Subtotal					4,871.00
Variable costs, field production, harvest					7,214.54
Interest: years 1, 2, 3 and 4 cost compounded @ 13% and cost of operating capital field production, harvest, 4 months @ 13%					983.73
Total, field production, harvest					8,198.27
Total variable costs					13,360.63

[a]The use of trade names is for illustration only and does not constitute an endorsement of any product.

[b]The plastic pots and trays are used for two years. The depreciation cost of the trays was calculated by dividing the initial value by the useful life of the trays.

[c]Dogwood liners used 12% of the bed space in the greenhouse. Consequently, only 12% of the cost of polyethylene film and shade cloth covering the greenhouse was charged to the dogwood liners. The polyethylene film covering is used two years and the shade cloth five years. Cost was assessed for each item accordingly.

[d]Related hired labor activities included time used for general maintenance of the propagation facility, repairs, purchasing supplies, time losses between jobs and other activities which could not be allocated to a specific crop. These hours were estimated at 20% of production labor hours.

[e]Includes machinery and equipment cost of flatbed truck.

propagation, and one 6.5-month period which completed the production cycle and included harvest. Similarly, Production System 2 was divided into four 12-month periods and one 8-month period. Table 7 presents data used for estimating variable costs of machinery and equipment.

An analysis of variable costs by cost categories is found in Table 8. Labor was the largest variable cost item for both production systems, accounting for 65 percent of total variable cost for Production System 1 and 60 percent for Production System 2. Labor cost per salable tree was $2.11 for Production System 1 and $2.34 for Production System 2. Production System 1 required 482 hired labor hours, or .11 hours per salable tree. Production System 2 required 674 hired labor hours, or .20 hours per salable tree. Hired labor requirements were greater for Production System 2 primarily because of the use of hired labor to take cuttings and maintain the cuttings in the greenhouse. Much of the propagation in Production System 1 was accomplished by use of contract labor. Also, the rooted cuttings occupied one acre of field space for three full growing seasons, and the budded seedlings for only two. Therefore, field growing of the rooted cuttings required more labor hours than did field growing of the budded seedlings. Contract labor requirements were greater for Production System 1. The scratching, budding and suckering operations were accomplished by use of contract labor and were not performed in Production System 2. The contract labor charge for these tasks was $719. The remainder of the difference in contract labor costs between the two systems was due to the smaller number of trees harvested in Production System 2. The

Table 7. Data for estimated cost per hour of use of machinery and equipment for a 50-acre field nursery, Tennessee, 1984

Item	New cost	Expected life	Estimated annual use	Repairs (% of new cost)	Variable costs per hour[a]
	dollars	years	hours		dollars
Tractor, 60 Hp	19,380	10	600	90	6.08
Tractor, 35 Hp	11,791	10	600	90	4.82
Tractor, 19 Hp	7,695	10	600	90	3.75
Articulated 4-wheel drive loader	38,000	10	600	90	9.42
Forks	1,100	10	600	90	.70
Flatbed truck	15,200	10	300	90	11.99
Plow	1,600	10	100	80	1.28
Disk	2,800	10	120	65	1.52
Harrow	266	10	120	65	.14
Cultimulcher	3,550	10	70	65	3.30
Rotovator	2,300	10	60	65	1.08
Sprayer, 10' boom	695	7	150	80	.74
Sprayer, Solo Back-Pack	115	10	60	90	.30
Transplanter, 2-row, 42" row	965	10	60	75	1.21
Transplanter, 2-row, 20" row	975	10	60	75	1.22
Transplanter, 1-row	475	10	60	75	.59
Tree spade	4,695	4	60	80	3.47
Airblast sprayer, 300 gal.	3,600	7	200	80	3.32
Rotary tiller	1,150	10	400	65	.97
Undercutter	250	7	60	75	.15
U blade	250	10	60	75	.20
Fertilizer sidedresser, 2-row	860	10	90	65	.62
Cultivator, 2-row	625	7	120	85	.63
Rotary mower, 5'	925	8	125	180	2.67
Wagon, 4-wheel	950	10	525	40	.29
Cultivator, 4-row	2,650	7	120	85	1.68
Truck, ½ T pickup	8,700	7	535	90	6.50
Package machine	4,100	10	60	65	2.48
Shears, electric	69	5	60	40	.10
Cyclone seeder	25	20	40	25	.02
Irrigation system	8,000	20	300	40	.75
Mist system	500	10	300	40	.25

[a] Includes fuel, lubrication cost and repairs. See: "Planning Budgets for Fruits, Vegetables: A Supplement to the Farm Planning Manual," Agricultural Extension Service, The University of Tennessee, EC 890 (Revised), January 1984.

Table 8. Analysis of variable costs by percentage of total variable cost and amount per salable *Cornus florida* cultivar, two production systems, B&B, Tennessee, 1984

	Production System 1			Production System 2		
	Variable cost	Variable cost per salable tree	Percent of total variable cost	Variable cost	Variable cost per salable tree	Percent of total variable cost
	----------dollars----------			----------dollars---------		
Materials	2,736.21	0.63	20	2,731.43	0.80	20
Machinery and equipment	262.99	0.06	2	530.89	0.16	4
Labor	9,149.84	2.11	65	7,907.12	2.34	60
Hired	(2,167.00)	(0.50)	(15)	(3,036.12)	(0.90)	(23)
Contract	(6,982.84)	(1.61)	(50)	(4,871.00)	(1.44)	(37)
Interest	1,884.67	0.43	13	2,191.19	0.65	16
	14,033.71	3.23	100	13,360.63	3.95	100

survival rate of the rooted cuttings in the field was 70 percent, providing 3,383 salable trees for harvest. The contract labor charge for harvest for this production system was $4,871 (Table 6), and the contract labor charge for harvest of the budded seedlings was $6,264 (Table 5). If the survival rate of the rooted cuttings in the field had been 90 percent, harvest cost for Production System 2 would be the same as for the budded seedlings and labor cost would be $9,300. Therefore, total labor requirements were less for Production System 2 primarily because contract labor expenditures for harvest were less.

An analysis of the effect on hired labor cost of a change in the hired labor wage rate is given in Table 9. In Production System 1, a change of $0.50 in the hired labor wage rate resulted in a change of approximately $240 in hired labor cost, or $0.05 per salable tree. In Production System 2, which utilized more hired labor, a change of $0.50 in the hired labor wage rate resulted in a change of approximately $337 in hired labor cost, or $0.10 per salable tree.

Materials was the second largest variable cost item, accounting for 20 percent of total variable cost for both production systems. Production System 2 required greater expenditures on materials during the propagation phase of production than did Production System 1, as seen by comparing Tables 5 and 6. Also, expenditures for fertilizer, herbicide, fungicide and insecticide were greater for Production System 2 because the rooted cuttings occupied one acre of field space one growing season longer than did the budded seedlings. However,

Table 9. Effect of changes in hired labor wage rate on hired labor cost, two production systems for Cornus florida cultivars, B&B, Tennessee, 1984

Hired labor wage rate[a]	Hired labor cost	
	Production System 1	Production System 2
	dollars	
3.50	1,685.66	2,361.42
4.00	1,925.92	2,698.80
4.50	2,167.00	3,036.12
5.00	2,407.40	3,374.50
5.50	2,648.12	3,710.82

[a]Includes basic wage, social security tax, worker's compensation and unemployment compensation.

since a greater number of salable trees was harvested in Production System 1, materials costs for harvest were greater for the budded seedlings. Total materials expenditures were approximately equal for the two systems. If the survival rate of the rooted cuttings in the field were 90 percent, materials cost for harvest of the rooted cuttings would be the same as for the budded seedlings. Materials cost for Production System 2 would then be $3,287.

Interest was the third largest variable cost item, accounting for 13 percent of total variable cost for Production System 1 and 16 percent for Production System 2. Interest costs accumulated more rapidly for Production System 2 due to the higher initial investment in the rooted cutting operation. An analysis of variable costs as affected by the interest rate is given in Table 10. Data in this table indicate that variable costs in Production System 2 were more sensitive to changes in the interest rate than were variable costs in Production System 1. In Production System 1, cost of interest per salable tree increased approximately $0.04 for each percent increase in the interest rate. In Production System 2, cost of interest per salable tree increased approximately $0.06 for each percent increase in the interest rate.

Machinery and equipment was the smallest variable cost item. Machinery and equipment costs were substantially higher for Production System 2 primarily due to costs incurred during propagation, in particular the cost of overwintering. Machinery and equipment cost per salable tree was $0.06 for Production System 1 and $0.16 for Production System 2.

Table 10. Effect of changes in interest rate on variable costs, two production systems for *Cornus florida* cultivars, B&B, Tennessee, 1984

Interest rate	Production System 1				Production System 2			
	Total variable cost	Cost of interest	Cost of interest per salable tree	Percent of total variable cost	Total variable cost	Cost of interest	Cost of interest per salable tree	Percent of total variable cost
Percent	----------dollars----------				----------dollars----------			
11	13,711.58	1,562.54	0.36	11	12,981.68	1,812.24	0.54	14
12	13,871.05	1,722.01	0.40	12	13,169.10	1,999.60	0.59	15
13	14,033.71	1,884.67	0.43	13	13,360.63	2,191.19	0.65	16
14	14,199.64	2,050.60	0.47	14	13,556.35	2,386.91	0.70	18
15	14,368.81	2,219.77	0.51	15	13,756.44	2,587.00	0.76	19

Total variable cost for Production System 2 was less than total variable cost for Production System 1 primarily because the rooted cuttings had a lower survival rate in the field than did the budded seedlings, resulting in lower contract labor and materials expenditures during harvest. If the rooted cuttings had the same survival rate in the field as the budded seedlings, total variable cost would be higher for the rooted cuttings. Materials cost would be $3,287 and labor cost would be $9,300. Substitution of these figures into Table 8 results in a total variable cost of $15,309 for Production System 2, not including slightly higher costs for interest and pruning, fungicide and insecticide in the field.

Variable cost data indicate that there was no overall cost advantage in producing dogwood cultivars from rooted cuttings rather than from budded seedlings.

Fixed Costs

Capital requirements for the 50-acre nursery are given in Table 11. Annual fixed costs (Table 12) associated with the capital requirements of land and improvement, buildings, and machinery and equipment were $56,494. This figure includes the costs of depreciation, interest, and insurance and taxes. Not all machinery and equipment described was employed in production of dogwoods but was considered important in the ongoing operation of the nursery. Annual expenditures on general overhead were $71,888, with an interest charge on general overhead of $4,673. Total annual fixed cost for the nursery was $133,055.

Table 11. Capital requirements for a 50-acre field nursery, Tennessee, 1984

Item	Description[a]	Unit	Useful life	Quantity	Cost per unit	Total initial cost	Salvage value
			years		dollars		
Land and improvements	Unimproved land	acre	--	50	2,000	100,000	---
	Grading, road building, graveling	---	20	---	---	25,530	---
Subtotal						125,530	
Buildings							
Office and restrooms	20' x 40'	sq.ft.	20	800	25	20,000	---
Plant and supply storage	40' x 50'	sq.ft.	20	2,000	18	36,000	---
Machinery storage and shop	40' x 100'	sq.ft.	30	4,000	3	12,000	---
Polyhouse structure, no heat	24' x 96'	each	10	3	1,250	3,750	---
Polyhouse structure, with heat	24' x 96'	each	10	2	2,150	4,300	---
Subtotal						76,050	
Machinery and equipment							
Tractor, 60 Hp	60 Hp, gas fuel	each	10	1	19,380	19,380	4,250
Tractor, 35 Hp	35 Hp, gas fuel	each	10	1	11,791	11,791	3,500
Tractor, 19 Hp	19 Hp, diesel fuel, "Kubota"	each	10	1	7,695	7,695	2,600
Articulated 4-wheel drive loader	"Swinger 320" - Lift cap. = 3,000 lbs.	each	10	1	38,000	38,000	4,000
Forks	For front-end loader	each	10	2	1,100	2,200	200
Flatbed truck	24', 1½ T, dual wheels	each	10	1	15,200	15,200	2,000
Plow	3-14" plows	each	10	1	1,600	1,600	160
Disk	8' wide, tandem, mtd.	each	10	1	2,800	2,800	280
Harrow	10' wide	each	10	1	266	266	25
Cultimulcher	10' wide	each	10	1	3,550	3,550	350
Rotovator	38" mtd.	each	10	1	2,300	2,300	230
Sprayer	100 gal. tank with 7' and 10' booms	each	7	1	695	695	60

Table 11. (Continued)

Item	Description[a]	Unit	Useful life	Quantity	Cost per unit	Total initial cost	Salvage value
			years		dollars		
Sprayer	Solo Back-Pack	each	10	1	100	100	---
Transplanter, 2-row	2-42/48" row field transplanter	each	10	1	965	965	100
Transplanter, 2-row	2-20" row bed transplanter	each	10	1	975	975	100
Transplanter, 1-row	Tree plants	each	10	1	475	475	50
Tree spade	CT20 3P handles 20", 22", 24"	each	4	1	4,695	4,695	450
Airblast sprayer	300 gal. high pressure on trailer, "Meyer"	each	7	1	3,600	3,600	510
Rotary tiller	8 Hp reartine	each	10	1	1,150	1,150	100
Undercutter	Bed undercutter, 50" blade, lift tines	each	7	1	250	250	25
U blade	18" for undercutting	each	7	1	179	179	25
Fertilizer sidedresser	2-row sidedresser	each	10	1	860	860	85
Cultivator, 2-row	2-row field cultivator	each	7	1	625	625	50
Rotary mower, 5'	5' mounted	each	8	1	925	925	100
Wagon	4 wheel farm wagon	each	10	2	950	1,900	200
Truck	½ T pickup truck	each	7	1	8,700	8,700	850
Package machine	For sleeve packed bare root plants	each	10	1	4,100	4,100	500
Pallets	Wooden	each	2	50	20	1,000	100
Shears	Electric	each	5	1	69	69	---
Cyclone seeder	Hand operated	each	20	1	25	25	---
Hand and service tools	Miscellaneous	---	5	---	---	2,000	200
Irrigation system	Pumps, controls, PVC pipe, nozzles--for propagation	---	20	1	8,000	8,000	500
Mist system	---	each	10	2	500	1,000	100
Subtotal						147,070	
TOTAL						348,650	

[a]The use of trade names is for illustration only and does not constitute an endorsement of any product.

Table 12. Annual fixed costs for a 50-acre field nursery, Tennessee, 1984

Item	Description	Depreciation[b]	Interest[c]	Insurance and taxes[d]	Total
		dollars			
Land and improvements	Unimproved land	---	13,000	500	13,500
	Grading, road building, graveling	1,276	3,319	128	4,723
Subtotal					18,223
Buildings					
Office and restrooms	20' x 40'	1,000	1,300	400	2,700
Plant and supply storage	40' x 50'	1,800	2,340	720	4,860
Machinery storage and shop	40' x 100'	400	780	240	1,420
Polyhouse structure, no heat	24' x 96'	375	244	75	694
Polyhouse structure, with heat	24' x 96'	430	280	86	796
Subtotal					10,470
Machinery and equipment[e]					
Tractor, 60 Hp	60 Hp, gas fuel	1,513	1,537	388	3,438
Tractor, 30 Hp	30 Hp, gas fuel	829	994	236	2,059
Tractor, 19 Hp	19 Hp, diesel fuel, "Kubota"	510	669	154	1,333
Articulated 4-wheel drive loader	"Swinger 320" - Lift cap. = 3,000 lbs.	3,400	2,730	760	6,890
Forks	For front-end loader	200	156	44	400
Flatbed truck	24', 1½ T, dual wheels	1,320	1,119	304	2,743
Plow	3-14" plows	144	114	32	290
Disk	8' wide, tandem, mtd.	252	200	56	508
Harrow	10' wide	24	19	5	48
Cultimulcher	10' wide	320	254	71	645
Rotovator	38", mtd.	207	164	46	417
Sprayer	100 gal. tank with 7' and 10' booms	91	49	14	154
Sprayer	Solo Back-Pack	10	6	2	18
Transplanter, 2-row	2-42/48" row field transplanter	87	69	19	175
Transplanter, 2-row	2-20" row bed transplanter	88	70	20	178
Transplanter, 1-row	Tree plants	42	34	10	86
Tree spade	"CT20 3P" handles 20", 22", 24"	1,061	335	94	1,490
Airblast sprayer	300 gal. high pressure on trailer, "Myer"	441	267	72	780
Rotary tiller	8 Hp reartine	105	81	23	209

Table 12. (Continued)

Item	Description	Depreciation[b]	Interest[c]	Insurance and taxes[d]	Total
		---------- dollars ----------			
Undercutter	Bed undercutter, 50" blade, life tines	32	18	5	55
U-blade	18" for undercutting	22	13	4	39
Fertilizer sidedresser	2-row sidedresser	78	61	17	156
Cultivator, 2-row	2-row field cultivator	82	44	13	139
Rotary mower, 5'	5' mounted	103	66	19	188
Wagon	4 wheel farm wagon	170	136	38	344
Truck	½ T pickup truck	1,122	622	174	1,918
Package machine	For sleeve packed bare root plants	360	299	83	742
Pallets	Wooden	450	72	---	522
Shears	Electric	14	4	2	20
Cyclone seeder	Hand operated	1	2	1	4
Hand and service tools	Miscellaneous	360	144	40	544
Irrigation system	Pumps, controls, PVC pipe, nozzles--for propagation	375	552	160	1,087
Mist system	---	90	72	20	182
Subtotal					27,801
General overhead					
Utilities	Telephone, electric, gas heat				4,250
General repairs and maintenance	Buildings and grounds				4,000
Licenses and bonds					325
Advertising and printing					1,200
Insurance, personnel	Workmen's comp., FICA, health, unemployment, etc.				7,488
Travel and entertainment					1,500
Professional fees					125
Administrative and management	Clerical, operators, and supervisory labor salaries				52,000
Miscellaneous	Office supplies				1,000
Subtotal					71,888
Interest on general overhead insurance, and taxes	Compounded at 13% per annum for 6 months				4,673
Total annual fixed cost					133,055

Table 12. (Continued)

[a]Small nursery: 50 total acres, 40 acres growing space, 10 acres production facilities, holding area, field bed area, roads, etc.

[b]Depreciation was estimated by dividing initial cost adjusted for salvage value by years of useful life.

[c]Interest cost for land was estimated by multiplying the initial value of the land by the interest rate per annum, 13%. Interest cost on buildings and machinery was estimated by taking 13% of the average value based on initial cost and salvage value. Calculated as initial value + salvage value ÷ 2 x 0.13.

[d]Insurance and taxes: on land, only taxes are assessed. Taxes were estimated at the rate of 2% per year at the rate of the assessed value which was 25% of market value. For land and improvements, buildings and machinery, insurance and taxes were an estimated cost based on 2% of the initial cost of the buildings and equipment.

[e]For machinery and equipment, depreciation, interest, taxes and insurance costs were adopted from Planning budgets for fruits and vegetables: A supplement to the Farm Planning Manual. EC 890 (Revised).

Fixed costs were assessed to the crops on a per acre basis. Forty acres of the nursery were in field production, so annual fixed cost per acre was $3,326. Production System 1 utilized a .18 acre propagation plot in the field for 26 months (2.17 years) and one acre of field space for 30.5 months (2.54 years). Total fixed cost assessed to Production System 1 was $9,748, or $2.24 per salable tree. The rooted cuttings occupied one acre of field space for 41.5 months, or 3.46 years. Total fixed cost for Production System 2 was $11,509, or $3.40 per salable tree. Fixed costs were greater for the rooted cuttings due to more intensive use of field space by Production System 2.

Total Costs and Returns

Total costs for the two production systems are analyzed in Table 13. Total cost for Production System 1, production by budded seedlings, was $23,782, or $5.47 per salable tree. Total cost for Production System 2, production from rooted cuttings, was $24,870, or $7.35 per salable tree. Variable cost was 59 percent of total cost for Production System 1 and 54 percent of total cost for Production System 2. Labor was the largest cost item for both production systems, accounting for 38 percent of total cost for Production System 1 and 32 percent of total cost for Production System 2. General overhead was the second largest cost item, accounting for 22 percent of total cost for Production System 1 and 25 percent of total cost for Production System 2. Both total variable and total fixed cost were higher under Production System 2.

Table 13. Analysis of total cost by percentage of total cost and amount per salable *Cornus florida* cultivar, two production systems, B&B, Tennessee, 1984

	Production System 1		Percent of Total Cost	Production System 2		Percent of Total Cost
	Cost	Cost per Salable tree		Cost	Cost per Salable tree	
	------- dollars -------			------- dollars -------		
Variable Costs:						
Materials	2,736.21	0.63	12	2,731.43	0.80	11
Machinery and equipment	262.99	0.06	1	530.89	0.16	2
Labor	9,149.84	2.11	38	7,907.12	2.34	32
Hired	(2,167.00)	(0.50)	(9)	(3,036.12)	(0.90)	(12)
Contract	(6,982.84)	(1.61)	(29)	(4,871.00)	(1.44)	(20)
Interest	1,884.67	0.43	8	2,191.19	0.65	9
Subtotal	14,033.71	3.23	59	13,360.63	3.95	54
Fixed Costs:[a,b]						
Land and improvements	1,335.11	0.30	6	1,576.28	0.46	6
Buildings	767.08	0.18	3	905.65	0.27	3
Machinery and equipment	2,036.84	0.47	9	2,404.79	0.71	10
General overhead	5,266.87	1.21	22	6,218.31	1.84	25
Interest on general overhead	342.36	0.08	1	404.21	0.12	2
Subtotal	9,748.26	2.24	41	11,509.24	3.40	46

Table 13. (Continued)

	Production System 1		Percent of Total Cost	Production System 2		Percent of Total Cost
	Cost	Cost per Salable tree		Cost	Cost per Salable tree	
	------- dollars --------			------- dollars -------		
Total	23,781.97	5.47	100	24,869.87	7.35	100

[a]Fixed costs were calculated from data in Table 12 and allocated to the dogwood crop as follows: annual fixed cost to the nursery divided by 40 (total acres in field production) times years per acre of field space utilized by the dogwood crop.

[b]The rooted cuttings were not assessed fixed costs during the time they occupied the small space in the greenhouse. For larger crop sizes requiring much greater greenhouse space, it would be necessary to consider fixed costs for time in the greenhouse.

Table 14 analyzes the cost of harvest for both production systems. Materials for harvest include burlap, twine, nails and tags. Contract labor includes digging the trees and moving them to the loading area.

Expected returns for the two production systems are shown in Table 15. Expected returns for Production System 1 ranged from $55,245 to $60,465. Expected returns for Production System 2, which had a lower survival rate in the field, ranged from $42,958 to $47,015. Selling prices for both production systems ranged from $9.00 for a three to four-foot dogwood cultivar to $17.00 for a five to six-foot dogwood cultivar.

An analysis of the effect of survival rates in the field on costs and returns is given in Table 16. Costs and returns decreased with a decrease in the field survival rates. At higher survival rates, Production System 2 became more cost competitive with Production System 1. However, even with a survival rate in the field of 90 percent, the cost of a dogwood cultivar produced from a rooted cutting was $0.70, or 13 percent, higher than the cost of a dogwood cultivar produced from a budded seedling. In this study, the survival rate in the field was assumed to be 90 percent for the budded seedlings and 70 percent for the rooted cuttings, and the cost differential per salable tree was $1.88. If the survival rate was 90 percent for the budded seedlings and 50 percent for the rooted cuttings, the cost differential per salable tree would be $4.08.

Table 14. Costs of harvest for Cornus florida cultivars, two production systems, B&B, Tennessee, 1984

	Production System 1			Production System 2		
	Cost	Cost per salable tree	Percent of total cost	Cost	Cost per salable tree	Percent of total cost
	----------dollars--------			---------dollars--------		
Contract labor	6,264.00	1.44	26	4,871.00	1.44	20
Materials	2,175.00	0.50	9	1,619.50	0.50	6
Total	8,439.00	1.94	35	6,490.50	1.94	26

Table 15. Expected returns per acre of Cornus florida cultivars at various wholesale price levels, two production systems, B&B, Tennessee, 1984[a]

Number and size of salable trees	Wholesale price per tree, level one	Gross Returns	Wholesale price per tree, level two	Gross Returns	Wholesale price per tree, level three	Gross Returns
	----------	----------	dollars	----------	----------	----------
Production System 1:						
435 3'-4'	10.00	4,350.00	9.00	3,915.00	10.00	4,350.00
2,610 4'-5'	12.00	31,320.00	12.00	31,320.00	13.00	33,930.00
1,305 5'-6'	15.00	19,575.00	16.00	20,880.00	17.00	22,185.00
Total 4,350		55,245.00		56,115.00		60,465.00
Production System 2:						
340 3'-4'	10.00	3,400.00	9.00	3,060.00	10.00	3,400.00
2,029 4'-5'	12.00	24,348.00	12.00	24,348.00	13.00	26,377.00
1,014 5'-6'	15.00	15,210.00	16.00	16,224.00	17.00	17,238.00
Total 3,383		42,958.00		43,632.00		47,015.00

[a]Assumes all trees sold. Prices taken from 1984 wholesale nursery price lists.

Table 16. Effect of survival rate in the field on costs and returns, two production systems for Cornus florida cultivars, B&B, Tennessee, 1984

Survival rate in the field	Number of salable trees	Cost of Harvest[a]	Total cost[b]	Cost per salable tree	Gross returns[c]	Net returns
-percent-		----------	dollars	----------		
Production System 1:						
90	4,350	8,439.00	23,781.97	5.47	56,550.00	32,768.03
80	3,866	7,518.20	22,861.17	5.91	55,220.00	32,358.83
70	3,383	6,490.50	21,833.47	6.45	43,972.00	22,138.53
60	2,900	5,626.00	20,968.97	7.23	37,700.00	16,731.03
50	2,416	4,687.20	20,030.17	8.29	31,410.00	11,379.83
Production System 2:						
90	4,350	8,439.00	26,818.37	6.16	56,550.00	29,731.63
80	3,866	7,518.20	25,897.57	6.70	55,220.00	29,322.43
70	3,383	6,490.50	24,869.87	7.35	43,972.00	19,102.13
60	2,900	5,626.00	24,005.37	8.28	37,700.00	13,694.63
50	2,416	4,687.20	23,066.57	9.55	31,410.00	8,343.43

[a]Includes cost of materials and cost of contract labor for digging and moving to loading area.

[b]Does not include change in interest costs; costs were compounded at 13 percent per annum over the duration of the production cycles.

[c]Assumes all trees sold at wholesale prices of $10.00 for 3'-4' trees, $12.00 for 4'-5' trees, and $16.00 for 5'-6' trees.

CHAPTER V

SUMMARY

The primary objective of this study was to develop cost models for production of flowering dogwood cultivars in Tennessee. Specific objectives included synthesizing model production systems for producing dogwoods from budded seedlings (Production System 1) and from rooted cuttings (Production System 2), estimating costs of production and the effect on costs of different assumptions about input prices and technical production coefficients, and comparing costs of production between the two production methods. Production data were gathered from Middle Tennessee nurserymen and from University of Tennessee research and extension personnel. Input prices and expected returns reflect 1984 conditions.

Total cost of growing a four to six-foot flowering dogwood cultivar from a budded seedling was estimated to be $5.47. Variable cost per salable tree was $3.23 and included $0.63 for materials, $0.06 for machinery and equipment, $0.50 for hired labor, $1.61 for contract labor, and $0.43 for interest on operating capital. Fixed cost per salable tree was $2.24 and included $0.95 for interest, depreciation, and insurance and taxes, $1.21 for general overhead and $0.08 for interest on general overhead.

Total cost of growing a four to six-foot flowering dogwood cultivar from a rooted cutting was estimated to be $7.35. Variable cost per salable tree was $3.95 and included $0.80 for materials,

$0.16 for machinery and equipment, $0.90 for hired labor, $1.44 for contract labor and $0.65 for interest on operating capital. Fixed cost per salable tree was $3.40 and included $1.44 for depreciation, interest, and insurance and taxes, $1.84 for general overhead and $0.12 for interest on general overhead.

Variable cost accounted for 59 percent of total cost per salable tree for Production System 1 and 54 percent of total cost per salable tree for Production System 2. Labor, including hired and contract, was the largest cost item for both production systems, accounting for 38 percent of total cost per salable tree for Production System 1 and 32 percent of total cost per salable tree for Production System 2. General overhead was the next largest cost item for the two production systems, accounting for 22 percent of total cost per salable tree for Production System 1 and 25 percent of total cost per salable tree for Production System 2.

Results of this study indicate that no cost advantage exists in producing flowering dogwood cultivars from rooted cuttings rather than from budded seedlings. The costs of maintaining the rooted cuttings in the greenhouse are greater than the expenditures saved by not employing contract labor for the budding operation. Also, lower survival rates of the rooted cuttings in the field lead to higher costs per salable tree. In this study the survival rate of the rooted cuttings in the field was assumed to be 70 percent. Actual survival rates may be much lower, especially in nurseries with no

field irrigation. However, under field irrigation and good cultural practices, survival rates may be higher.

Two important limitations should be recognized. First, total cost per salable plant is affected by size of nursery. As nursery size increases, total cost per salable plant tends to decrease. Most of the decrease in total cost per plant is due to the decrease in fixed cost per plant as fixed costs are spread over more salable units. In this study, cost information was developed assuming a one-acre crop of dogwood cultivars, produced either from budded seedlings or rooted cuttings, and a 50-acre field nursery. Many leading growers in Middle Tennessee produce larger crops of dogwood cultivars and operate larger nurseries. For example, the average size of the 14 nurseries interviewed was 446 acres. Thus, costs estimated may be somewhat higher than costs actually incurred by Middle Tennessee growers. Secondly, cost information was developed assuming the production methods and facilities described. Growers employing substantially different cultural practices and production facilities will incur costs different from those described here and may also have greater success in producing dogwoods from rooted cuttings.

As propagation knowledge and cultural practices improve, leading to higher survival rates in the field, production of flowering dogwood cultivars from rooted cuttings should become more cost competitive with production from budded seedlings and thus more feasible commercially. Production from rooted cuttings will be economically

practical primarily for larger nurseries with field irrigation and greenhouse facilities.

Further cost of production research is needed for the flowering dogwood and other important Tennessee nursery crops to follow improvements in cultural practices and to develop accurate and useful cost information. Topics of research should include costs and methods of field irrigation and costs of overwintering. In addition, the effects of economies of size on different production systems should be studied.

LITERATURE CITED

LITERATURE CITED

1. Aylesworth, J. and J. B. Gartner. 1972. The seven costs of ornamental production. Amer. Nurseryman CXXXV(2):11,12,116-122.

2. Badenhop, M. B. 1981. Marketing woody ornamental plants by Tennessee nursery wholesalers. Tn. Ag. Exp. Sta., Tn. Farm and Home Science No. 120.

3. Badenhop, M. B. and S-103 Technical Committee. 1979. Factors affecting southern regional production advantages for Juniperus chinensis 'Pfitzeriana.' Southern Cooperative Series Bull. No. 241.

4. _____. 1979. Factors affecting southern regional production advantages for Kurume azaleas. Southern Cooperative Series Bull. No. 241.

5. _____. 1980. Cost of producing and marketing a shade tree: the pin oak. Southern Cooperative Series Bull. No. 244.

6. _____. 1980. Factors affecting production costs and returns for flowering dogwood. Southern Cooperative Series Bull. No. 246.

7. Coutu, A. J. and S-103 Technical Committee. 1982. Nursery management and production costs: Burford holly Ilex cornuta 'Burfordii.' Southern Cooperative Series Bull. No. 274.

8. Crafton, V. W., T. D. Phillips and T. M. Blessington. 1982. Costs of producing woody ornamental plants. Ag. Econ. Res. Rep. 137, Ms. Ag. and Forestry Exp. Sta.

9. Dickerson, H. L. 1982. Cost of producing and marketing rooted cuttings of three woody ornamental species in three Middle Tennessee nurseries, 1980. Unpublished M.S. Thesis, Department of Ornamental Horticulture and Landscape Design, The University of Tennessee, Knoxville.

10. Doll, J. P. and F. Orazem. 1978. Production economics; Theory with applications. Grid, Inc., Columbus, Ohio.

11. Fries, Harry H. and Patrick J. Kirschling. 1974. Nursery stock in one-gallon containers: Production program and economic feasibility. New Jersey Ag. Exp. Sta., New Brunswick A.E. 353.

12. Gammell, W. A., Sr. 1981. Nursery business 100 -- the wholesale nursery industry -- 1981. Nursery Business 26(9):47-62.

13. Gunter, D. L. 1977. Business analysis of container nurseries in Florida, 1976. Univ. of Fla. Food and Resource Econ. Dept. Econ. Info. Rep. No. 83.

14. Hahn, D. E., J. L. Robertson and E. M. Smith. 1979. An analysis of production costs for containerized nursery products. Ohio Ag. Res. and Devel. Center Res. Cir. No. 246:3-7.

15. Hirshleifer. 1980. Price theory and applications. Prentice Hall, Englewood Cliffs, New Jersey.

16. Kneen, H. H. 1981. Comparison of costs for producing containerized and field grown Juniperus chinensis 'Pfitzeriana' in USDA Climatic Zones 6 and 7. Unpublished M.S. Thesis, Ohio State Univ., Columbus.

17. Lauderdale, J. 1981. Monrovia figures costs for liners in new beds. Amer. Nurseryman CLIV(5):82-84,86.

18. Nicholson, H. 1977. Field budding of dogwood. Inter. Plant Prop. Soc. Combined Proc. 27:236-238.

19. Padgett, J. H. and T. L. Frazier. 1962. The relationship between costs and pricing of woody ornamentals. Univ. of Ga. Ag. Exp. Sta. Bull. N.S. 100.

20. Padgett, J. H. 1966. Costs of producing field-grown stock. Amer. Nurseryman CXXIII(1):11,12,84.

21. Perry, F. B., Jr. and M. B. Badenhop. 1982. Production and marketing of woody ornamentals in Alabama. Alabama Ag. Exp. Sta. Bull. No. 546.

22. Powers, E. W. 1978. An analysis of production costs for containerized nursery products. Unpublished M.S. Thesis, Ohio State Univ., Columbus.

23. Robertson, J. L., D. B. Perry and A. J. Supowit. 1980. Computer analysis of production costs for containerized nursery products. Ohio Ag. Res. and Devel. Center Res. Cir. No. 253:3-8.

24. Scott, J. T., Jr. and J. Q. Aylesworth. 1974. Production costs and time to sell nursery stock. Dept. of Ag. Econ., Univ. of Illinois, Urbana A.E. 4352.

25. Smeal, P. L., J. S. Coartney and K. E. Loope. 1974. The economics of establishing a shade tree nursery. Virginia Polytech. Inst. and State Univ. Pub. 592.

27. Taylor, R. D., H. H. Kneen, D. E. Hahn, and E. M. Smith. 1983. Costs of establishing and operating container nurseries differentiated by size of firm and species of plant in USDA Climatic Zone 6. Southern Cooperative Series Bull. No. 301.

28. Tennessee Department of Agriculture Crop Reporting Service. 1984. Tennessee Agricultural Statistics 1984 Annual Bulletin T-21.

29. Tennessee Department of Agriculture Insect and Plant Disease Control Section. 1984. Tennessee Nurseries Collectors and Plant Dealers Certified 1983-84.

30. University of Tennessee Agricultural Extension Service. 1984. Planning budgets for fruits and vegetables: A supplement to the farm planning manual. EC 890 (Revised).

31. Williams, D. B., W. T. Witte, C. H. Hadden and H. E. Williams. 1983. The flowering dogwood in Tennessee. Univ. of TN. Ag. Ext. Service Pub. 589.

32. Witte, W. T. 1978. Cornus florida cultivar list. Univ. of Tn. Ag. Ext. Service Fact Sheet No. 78-5.

33. Yager, E. 1978. Cost of liner production at Cartwright Nurseries. Inter. Plant Prop. Soc. Combined Proc. 28:292-293.

VITA

Thomas Edward Glasgow was born in Nashville, Tennessee, on June 3, 1958. He attended elementary and secondary schools in Erwin, Tennessee, Cincinnati, Ohio, and Bristol, Tennessee and was graduated from Bristol Tennessee High School in 1976. In 1980 he was awarded a Bachelor of Science degree in Ornamental Horticulture and Landscape Design from The University of Tennessee, Knoxville.

In March 1985 he was awarded the Master of Science degree from The University of Tennessee, Knoxville with a major in Agricultural Economics. While working toward the degree he was employed by the Tennessee Agricultural Experiment Station as a Graduate Research Assistant in Agricultural Economics.